

# Review of NASA's Earth Science Enterprise Applications Program Plan

Committee to Review NASA's Earth Science Enterprise Applications Plan  
Space Studies Board  
Division on Engineering and Physical Sciences  
NATIONAL RESEARCH COUNCIL  
OF THE NATIONAL ACADEMIES

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## Preface

NASA's Earth Science Enterprise (ESE) has developed a draft strategic plan, *Earth Science Enterprise Applications Strategy for 2002-2012*, for the ESE Applications Program. The Committee to Review NASA's Earth Science Enterprise Applications Strategy was established under the auspices of the Space Studies Board to review the January 2002 document, with particular emphasis on the following (see Appendix A):

1. Examination of the overall goals, strategy, and approach for the program;
2. Review of the planning and prioritization process, operations concept, expected program results or deliverables, and performance measures; and
3. Assessment of how well the approach outlined in the plan will serve to advance NASA's stated goals and objectives for the ESE Applications Program.

The plan describes the direction of the ESE Applications Program for the period from 2002 through 2012. The document includes the program mission, goals, planning strategy, a concept of operations to implement the strategy, and performance measures by which to evaluate the program.

In conducting its study, the committee considered several sources of input: previous National Research Council (NRC) reports, briefings and supplementary material provided by NASA, and discussions with representatives of the Office of Management and Budget, congressional staff, and two of NASA's collaborating agencies—the Federal Emergency Management Agency (FEMA) and the National Oceanic and Atmospheric Administration (NOAA).

The committee would like to acknowledge the following individuals who briefed the committee or provided other input: Ghassem Asrar (NASA), Ron Birk (NASA), Paul Carliner (Senate Appropriations Committee), Marie Colton (National Oceanic and Atmospheric Administration), Claire Drury (Federal Emergency Management Agency), Sarah Horrigan (Office of Management and Budget), Margaret Lawless (Federal Emergency Management Agency), Scott McAfee (Federal Emergency Management Agency), Matt Miller (Federal Emergency Management Agency), Scott Pace (NASA), Rose Parkes (Federal Emergency Management Agency), Edward Sheffner (NASA), and Greg Williams (NASA).

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the authors and the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Susan Avery, University of Colorado,  
Efi Foufoula, University of Minnesota,

Inez Fung, University of California at Berkeley,  
Robert Huggett, Michigan State University, and  
Mark Schaefer, NatureServe.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by William J. Merrell, Jr., Texas A&M University. Appointed by the National Research Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.



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# I

## Introduction

### Background

The Earth Science Enterprise (ESE) is one of four science and technology program offices within the National Aeronautics and Space Administration (NASA). The ESE deals with space missions and research aimed at observing and “understanding the Earth system and its responses to natural and human-induced changes to enable improved prediction of climate, weather, and natural hazards for present and future generations.”<sup>1</sup> Approximately 34 percent of the \$1.6 billion ESE budget for FY2002 is devoted to research and technology, and 50 percent is spent on mission development and operations.<sup>2</sup> The Applications Division within the ESE has responsibility for both the ESE Applications Program and its education and public outreach activities. The total Applications Division budget in FY2002 is \$95 million, of which \$77 million is allocated to applications.<sup>3</sup>

The Conference Report (House Report 106-988) accompanying the FY2001 VA-HUD-Independent Agencies Appropriations Act (Public Law 106-377) directed NASA to develop a 10-year strategy and funding profile to extend the benefits of Earth science, technology, and data results beyond the traditional science community and address practical, near-term problems. In addition, the Conference Report (House Report 106-843) accompanying the NASA Authorization Act for FY2000-2002 (Public Law 106-391) directed NASA to report on the Agency’s long-term plan to promote scientific applications of U.S. commercial remote sensing capabilities through the purchase of data, development of applications, and collaboration with industry, research universities, and other government agencies.

As a part of the ESE strategic planning process, the ESE program office prepared a science plan, *NASA Earth Science Enterprise Research Strategy for 2000-2010*, which was reviewed by the National Research Council (NRC) in 2000.<sup>4</sup> The present report reviews the ESE Applications Plan, *Earth Science Enterprise Applications Strategy for 2002-2012*.

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<sup>1</sup>NASA, 2000, *Exploring Our Home Planet: Earth Science Enterprise Strategic Plan*.

<sup>2</sup>Details of the FY2002 budget are given online at < [http://ifmp.nasa.gov/codeb/budget2003/14-Earth\\_Science.pdf](http://ifmp.nasa.gov/codeb/budget2003/14-Earth_Science.pdf)>.

<sup>3</sup>NASA’s budget request for FY2003 includes a total of \$43.6 million for applications. According to NASA and OMB officials, the difference between FY2002 and FY2003 reflects the fact that the administration did not request continuation of additions made to the budget by the Congress during the FY2002 appropriations process.

<sup>4</sup>NRC, 2000, *Review of NASA’s Earth Science Enterprise Research Strategy for 2000-2010*, Space Studies Board, National Academy Press, Washington, D.C., 41 pp.

## **Charge and Approach**

The *Earth Science Enterprise Applications Strategy for 2002-2012* (the Applications Plan<sup>5</sup>) was prepared in January 2002. In response to a request from NASA (Appendix A), the Committee to Review NASA's Earth Science Applications Plan was established by the Space Studies Board of the National Research Council. The committee was asked to assess the following: (1) the overall goals, strategy, and approach for the ESE Applications Program, (2) the planning and prioritization process, operations concept, expected program results or deliverables, and performance measures, and (3) how well the approach outlined in the plan will serve to advance NASA's stated goals and objectives for the ESE Applications Program.

Chapter II of the committee's report summarizes its general findings and recommendations. Chapter III provides a more detailed discussion of the committee's recommendations regarding the individual sections of the Applications Plan. Finally, the committee's conclusions are summarized in Chapter IV.

## **The ESE Applications Plan**

The Applications Plan consists of a preface; four main sections that address (1) program vision, missions, and goals as well as context with respect to the broader ESE program, (2) program planning strategy, which includes a discussion of the priorities for selection of candidate applications, (3) program operations, which includes aspects of program management and implementation, and (4) performance evaluation measures; and a short summary and several appendices. In briefings to the committee, NASA representatives elaborated on the material that appears in the Applications Plan and noted that NASA's applications strategy has evolved and is expected to continue to evolve over time.

In briefings to the committee, Office of Management and Budget and NASA officials noted that in the 1990s accelerating the U.S. commercial remote sensing industry was a NASA priority, and later in the period the ESE Applications Program emphasized pilot projects and demonstrations at the state and local level. The efforts, which were often funded via grants to state, local, tribal, and university entities, focused on building government-to-citizen relationships. The current NASA applications strategy adopts a modified approach that adds an emphasis on national (as opposed to local) "benchmark" applications that utilize NASA partnerships with other federal agencies ("government-to-government-to-citizen relationships"). According to NASA officials, this modified strategy will capitalize on NASA systems engineering expertise and NASA data and scientific capability to help NASA's federal partners develop decision support tools<sup>6</sup> for a

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<sup>5</sup>Throughout this report, the committee uses "the Applications Plan" to refer to the NASA document and "the NASA applications strategy" to refer to the suite of approaches and ideas on which the ESE Applications Program is founded and according to which it will be executed.

<sup>6</sup>In briefing the committee, NASA officials defined decision support tools as "interactive, computer-based systems designed to help people and organizations retrieve, summarize, and analyze data and information and conduct predictive analysis on scenarios that enable enhanced capacity to make better decisions."

variety of specific applications. NASA refers to the former strategies as the “heritage program” and the current, augmented approach as the “go forward” strategy. (See Appendix B.)

NASA described to the committee a set of key strategic principles on which the ESE Applications Program will be founded in the future.<sup>7</sup> They are as follows:

- Extend the use of NASA/ESE climate, weather, and natural hazards research for the social and economic benefit of the nation.
- Focus on application areas of demonstrated national significance.
- Define specific applications through joint projects with users.
- Provide a systems engineering role for the user community—data and measurements, modeling, and decision support.
- Rely on users to supply the operational environment and operational support.

The Applications Plan describes a process whereby candidate applications are selected based on their potential to address national needs, after which the candidate areas are prioritized on the basis of the following eight criteria, listed in descending order of importance:

1. Socio-economic value,
2. Application feasibility,
3. Response to executive or legislative branch direction,
4. Appropriateness for NASA,
5. Opportunity for collaborative partnership,
6. Scientific and technological readiness,
7. Program balance, and
8. Cost and budget context.

The January 2002 draft of the Applications Plan includes an appendix that lists five representative examples of applications topics and federal agency partners—wild fire management with the U.S. Forest Service, coastal beach mapping with NOAA, agriculture crop greenness and production assessment with the U.S. Department of Agriculture (USDA), hurricane track prediction with NOAA, and aviation safety through synthetic vision systems with the Federal Aviation Administration (FAA). In briefing the committee NASA indicated that this list has been expanded to the following set of 12 areas of national priority for initial emphasis in the program.<sup>8</sup>

1. Enhanced weather prediction for energy forecasting,
2. Weather and climate prediction for agricultural competitiveness,
3. Carbon sequestration assessment for carbon management,
4. Digital atmosphere and terrain visualization for aviation transportation safety,
5. Early-warning systems for air and water quality for homeland security,

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<sup>7</sup>Presentation by Edward Sheffner, NASA, on August 1, 2002.

<sup>8</sup>Preprint of article to appear in the August 2002 issue of *Earth Observation Magazine (EOM)*, “Science and Society,” by R. Birk and C. Hutchinson.

6. Environmental indicators for community growth management,
7. Integrated hurricane and flooding prediction for community disaster preparedness,
8. Early-warning systems for vector-borne infectious diseases for public health,
9. Environmental indicators for coastal management,
10. Environmental models for biological invasive species,
11. Water-cycle assessments for water management and conservation, and
12. Regional, national, and international atmospheric measurements and predictions for air quality management.

NASA officials told the committee that the initial applications areas have been selected, partners have been identified, and initial roadmaps or program plans have been prepared. They reported that implementation approaches are being formulated and that the next steps will be to prioritize the selected areas and establish formal teaming arrangements with partners.

The Applications Plan concludes with a discussion of plans for program evaluation in compliance with the Government Performance and Results Act, and it lists a set of “inputs, outputs, outcomes, and impacts” by which NASA will judge success. In briefing the committee NASA officials also described the following program deliverables:

- Verification and validation reports on benchmark applications approaches,
- Documented prototypes and guidelines (procedures) that can facilitate potential operational implementation,
- Analyses and assessments regarding potential for commercial implementation, and
- Guidance for the next generation of research and development.

In the next chapters of this report, the committee presents its assessment of the NASA applications strategy, based on a review of the Applications Plan and statements by NASA officials that elaborated upon or modified the plan. Based on committee discussions with officials from NASA and a sampling of partner agencies, the report also offers suggestions and recommendations for ways to strengthen the Applications Plan.

## II

### General Findings and Recommendations

The committee was impressed by NASA's commitment to a strong applications program that will have a national impact. The Applications Plan contains many sections that serve as a good starting point for demonstrating that intent via a process that recognizes partnerships and shared applications of research results as critical contributions toward meeting NASA's mission. A number of aspects of the Applications Plan are especially noteworthy. Notable examples of elements of the Applications Plan that the committee applauds include the following:

- The mission statement for the ESE Applications Program is a good broad-based statement.
- The process of interacting with other federal agencies to reach a diverse group of users is a viable and appropriate avenue to pursue.
- The management approach and prioritization of criteria for evaluating candidate applications areas are well reasoned.
- The itemization of action steps is valuable for the overall process and strategy.
- The science is linked with the decision-making process using decision support systems.

While the Applications Plan does not have fundamental weaknesses, the committee makes a series of recommendations for its improvement. Some overarching themes have been drawn from committee discussions. They are listed here first either because they recurred throughout the document evaluation process, and/or because they stand as general guidance and feedback to NASA regarding ways to strengthen the overall NASA applications strategy.

- **The ESE Applications Program needs a period of stability and consistency of at least 5 years** so that managers, partners, and applications users can have time to implement the NASA applications strategy and bring proposed applications initiatives to fruition. Both NASA representatives and officials from outside the agency noted that earlier changes in emphasis had unintended consequences. The Applications Plan should strive to reinforce effective past practices and demonstrate linkages to successful data application strategies. The current draft of the Applications Plan lacks sufficient language regarding how the NASA applications strategy will build on past approaches and projects, even as the Applications Plan retains a forward-looking agenda that remains its primary focus.
- **The Applications Plan should address NASA's ongoing commitment to providing data, models, and infrastructure support for operational solutions needed to attain the 2010 goals.**

- Overall, **the Applications Plan needs a clearer sense of connectivity** in several different directions. This could be achieved by showing the linkages of (a) past strategies to the current strategy (as noted above), (b) the ESE Applications Program to other ESE programs, (c) the NASA applications strategy's links to implementation and budgeting processes, and (d) NASA roles and responsibilities with respect to those of partners (see below).
- **The theme of partnerships has been invoked in the NASA applications strategy, but it has not been fully realized in definition, scope, or practice.** For example, the Applications Plan would benefit from a description of how the needs of partner federal agencies will be identified and when in the process of transition from research to operations these processes will be initiated. The opening section of the Applications Plan should document efforts by NASA to involve partners in the development of the NASA applications strategy itself, not only to demonstrate credibility, but also to reinforce NASA's commitment to sharing credit as well as information.

The relationship between partnering and implementation of applications is underdeveloped. Without a clear statement regarding the role of partners in the implementation of the NASA applications strategy and the application of data, the partnering function will resemble a "hand-off" rather than an inclusive, interactive, and collaborative process. Further, the establishment of a feedback mechanism should be an important concept within the partnerships that helps to define mutually agreed upon success/transition criteria or metrics. Such feedback should improve collaboration regarding next steps, suggest revisions for improving ineffective existing steps, and contribute to defining needs for future science research. The committee believes that the importance of end users and the private sector's role as a performer or as a partner should also be prominently featured. Illustrative examples of past success would be useful.

The Applications Plan's references to eight large clusters of stakeholder groups may be an unwieldy way to reach potential partners, running the risk of over-generalization and promoting "sampling" as opposed to true partnering. The accomplishment of goals as outlined in Table 1 of the document will depend on other federal agency action as much as action by NASA; more details are needed regarding how partner participation is ensured, how it is measured, and how to create "buy-in."

Finally, while the Applications Plan cites partnerships that relate almost exclusively to federal partners, the committee could not determine whether NASA also contemplates primary partnerships with non-federal partners or whether those partnerships will be only or mainly derivative. The committee believes that NASA should recruit partners using open announcements in an effort to expand the pool of partners.



- **The Applications Plan could benefit from more attention to its intended audience.** The document does not clearly specify an intended audience, beyond all-inclusive references to the American people. More importantly, while the intended audience may be reasonably knowledgeable people within OMB and Congress, the Applications Plan will be read by a broader audience and therefore must provide greater context, perhaps at the expense of brevity, to facilitate better communication and avoid generating unintended consequences or misinterpretations.
- **The Applications Plan needs to articulate a strategy for translating concepts into more tangible actions.** A number of concepts could benefit from further development and explanation. Among the needed improvements are a stronger opening statement as to why the strategy is necessary and why this particular strategy is the best approach; an explanation of how the plan reflects consultation with non-NASA stakeholders; a more specific identification of who the program is for and how it is to be accomplished, including the role of Earth Science Information Partners Regional Earth Science Applications Centers, and others; a greater distinction between the general mission of ESE and the more specific mission of the ESE Applications Program; a specific rationale for conveying a 10-year commitment for the strategy; clarification as to whether the strategy employs a "push" or "pull" (or "driver vs. response") approach with partners, whether partners are primarily federal agencies or others such as local governments are also included, and whether demonstration projects are still part of this strategy; responsibility of partners to co-fund; and clarification of the mechanism or strategy for the transfer of activity from NASA to its partners.

Finally, it would be most helpful if examples were given to illustrate the successful functioning of the process. Options for illustrative examples include a series of graphic diagrams, or tracing one example throughout the Applications Plan to illustrate how the various processes would apply.

On the whole, the recommendations of the committee are designed to increase understanding, eliminate confusion, and improve the acceptance of the NASA applications strategy by a wide audience of potential partners, users, and other interested parties. The committee endorses the efforts of NASA to explore new and improved approaches to its function of applying Earth sciences information in a useful and collaborative fashion.

### III

## Section-Specific Findings and Recommendations

In reviewing the Applications Plan, the committee sought to carefully evaluate the content of each section, consider the purpose of each section in the context of the whole document, and identify the strengths and weaknesses of each section in that context.

### Recommendations Regarding the Preface

The committee found that the preface would strengthen the Applications Plan overall if this section (or a subsequent introductory section to the document) were revised to better set the stage for the rest of the Applications Plan and effectively summarize the key aspects of the NASA applications strategy. To do this, the committee first recommends the inclusion of the following “big picture” information:

1. NASA should more clearly identify the audience for the Applications Plan. For whom is it being written? Who else might read it? What does NASA expect this audience to gain from reading the Applications Plan?
2. NASA should more clearly articulate both the scope and the boundaries of the NASA applications strategy. This would include a discussion of the following:
  - a. How the current strategy relates to previous efforts within the Earth Science Enterprise to direct the Applications Division and how those efforts constituted a prologue to this one.
  - b. How the current strategy sets up the framework for the future implementation of specific program elements, or, how the current Plan lays the foundation for a future implementation plan, since this document is not intended to include an implementation plan.

An expanded introductory section could provide a valuable opportunity to address several overarching themes, such as the set of key strategic principles that NASA described to the committee (see page 3 above). For example:

1. The section could discuss in greater detail the meaning and implications of the term “partnerships.”
2. The section could provide a clearer context for its current discussion of specific missions (i.e., GRACE and CALIPSO) in order to make it clear why that discussion is necessary and how those missions, and the data they provide, fit within the strategy.
3. The section might also include a list of drivers for the Applications Division that are similar to the list of questions it includes that drive the science programs in the ESE.

By addressing these issues the expanded section will more clearly articulate the objectives of the strategy and more appropriately set the stage for the details of the Applications Plan as they are laid out in the body of the document. In its current form the Applications Plan contains nothing to introduce some of the critical concepts that must be understood early on if the reader is to follow the Applications Plan from beginning to end. The committee believes that including discussions of the themes and contextual material described above will strengthen the preface or a new introductory section in this regard.

### **Comments Regarding Section 1: Vision, Plans, Mission, and Goals**

To achieve consistency and clarity throughout the Applications Plan the committee recommends that the following improvements be considered:

#### *Section 1.1 – NASA Vision*

The statement in paragraph 3, “Specific elements of the ESE contributions to the visions are . . .” is ambiguous with respect to whether it refers to the Earth Science Enterprise as a whole or to the ESE Applications Program itself. The bullets appear to neglect an intended role for the private sector.

#### *Section 1.2 – ESE Heritage and Plans*

In references to ESE in general and the ESE Applications Program, it is not clear which is being referred to.

Table 1 refers to NASA ESE plans for predictive capabilities. However, these capabilities cannot be achieved without transitioning results to the partner operational agency. For example, Table 1 states research goals for 2010, but NOAA has the operational responsibility for weather forecasting. It is important that some reference be made to the operational agency’s involvement in implementation as a condition of achieving the stated goals, even though they are NASA ESE goals. If these goals are important to the ESE Applications Program, then they should be put into the context of the program and not just be included as research goals.

The committee noted that the FAA was not included in the list of agencies at the end of Section 1.2, although other NASA material cites FAA partnerships.

#### *Section 1.2b – ESE and Applications Missions*

Paragraph 3 refers to NASA and its partners but does not define the partners. It would be useful to define who the partners are, such as federal agencies, state and local governments, the private sector, or the academic sector. Execution of the strategy relies heavily on partnerships. Consequently the discussion of partnerships should be expanded for clarity and completeness. When federal agencies are named as examples, if there are

corresponding non-federal partners, the committee recommends listing these examples also to illustrate that NASA's partnerships reach beyond the federal sector.

A footnote or glossary entry that defines "biogeophysical sciences" would be useful.

### *Section 1.3 – Applications Program Goals*

The goals do not include any mention of a feedback process for identifying user needs and assessing success. User needs can provide a requirements "pull" that could drive the Earth System Science Research Program. Right now the Applications Program appears to be "pushed" as a science-driven program. In discussions with the committee, NASA representatives described cases where user feedback is being obtained, but the basic utility or importance of such feedback is not especially reflected in the Applications Plan. The committee also noted that the last goal listed in Section 1.3 does not include the private sector and other non-government partners.

## **Comments and Recommendations Regarding Section 2: Program Planning Strategies**

The committee felt that the three-stage organization of the program planning strategy seemed practical and that the existing content of the Applications Plan subsections on these topics was useful. However, as is the case elsewhere in the document, the partners' role in the planning process needs elaboration. Furthermore, the Applications Plan could be strengthened by the addition of specific case studies or examples of how the planning process might proceed. Finally, the committee assumes that the first sentence of Section 2.0 is intended to indicate that identification and selection of needs constitute a *first* step toward accomplishing the program goals, rather than the sole step, with the implication that subsequent effort will be focused on effectively accomplishing identified tasks.

### *Section 2.1 – Identification of Candidate Applications*

Section 2.1 is a notable case where the role of the proposed partnerships is not readily apparent. The committee could not discern how input from partners about their needs would be considered. As this section reads, it appears that the planning process is driven more by "technology push" than by "user pull." It was especially difficult to discern how user levels beyond federal agencies, or even federal agencies for that matter, would have input. The committee felt strongly that, for the proposed linkages with partners to be ultimately successful, the partners would have to be substantively involved in every aspect of planning, implementation, and evaluation of applications. With regard to the 12 national applications identified to date,<sup>9</sup> the plan should discuss how these were selected (e.g., at the five regional workshops) and the extent to which partners and other stakeholders were involved. The plan should also discuss the process by which the list of

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<sup>9</sup>Preprint of article to appear in the August 2002 issue of Earth Observation Magazine (*EOM*), "Science and Society," by R. Birk and C. Hutchinson.

national applications will be revised and to what extent partner and stakeholder input will be utilized.

The committee recommends that ecological impacts be included in NASA's 12 national application areas where appropriate. This will permit NASA to take advantage of biological program elements of research on climate, weather, and natural hazards.

As part of an effort to address these issues, it might be helpful if some of the details about information gathering and communication activities currently listed in Section 3.4 were introduced in Section 2.1 first. Including a sidebar or "box" detailing an illustrative example for each step in the process of identifying a specific candidate application would also be useful. The wildfire management application cited by NASA in a discussion with the committee<sup>10</sup> would be an effective example.

### *Section 2.2 – Prioritization/Selection of Applications*

Section 2.2 includes a reasonable and justified list of selection and prioritization criteria, and it effectively sets the stage for the selection process. What is missing, however, is some discussion of how the information needed to rank candidate applications against these criteria is collected, for example, whether this information was gleaned in part at the regional workshops cited by NASA in discussions with the committee.<sup>11</sup> Lastly, it would be instructive if this section contained an example of how an application was selected using the prioritized criteria presented in this section of the Applications Plan.

### *Section 2.3 – Identification/Selection of Projects for Applications*

The committee concluded that it is necessary to clarify whether the process described in Section 2.3 for implementing individual applications applies specifically to ESE Applications or whether, as implied by the first sentence, it describes a role for ESE in general. If the latter is the case, then what is the specific role for the ESE Applications Division?

Once again, in the committee's view, important details about the role of partnerships are lacking. Establishing "linkages" between NASA capabilities and specific partners and applications seems to be a critical element of the overall NASA applications strategy, but little detail is provided about how this will proceed. For example, will NASA's partners be involved in the process of solicitation and selection of project performers? And if so, how? Section 2.3 also might benefit from the addition of a box that gives relevant examples.

The committee supports the concept of soliciting for "performers" from the public, academic, and private sectors, and felt that a diagram describing the connections between NASA, a specific partner, and successful respondents to a solicitation might be helpful.

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<sup>10</sup>Presentation by Edward Sheffner of NASA on August 1, 2002.

<sup>11</sup>Presentation by Ronald Birk of NASA on July 30, 2002.

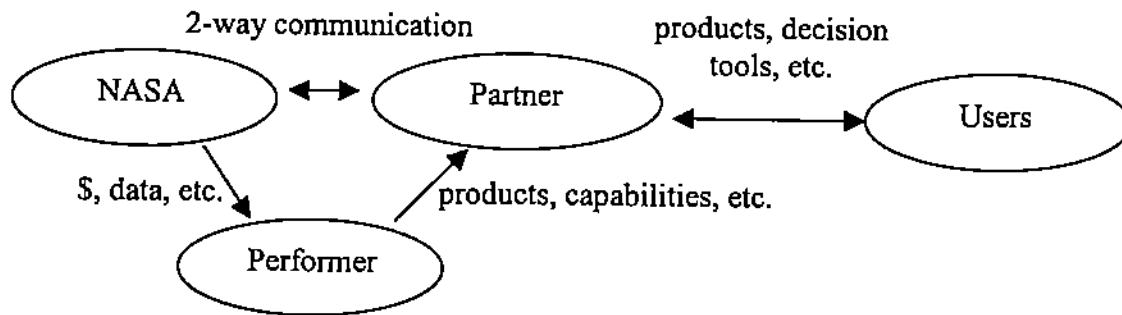


Figure 1. Example of how the Applications Plan might illustrate the relationships between NASA, its formal Applications Program partners, public or private sector “performers” that carry out specific applications projects, and end users.

Figure 1 is the committee’s simplified portrayal of how it understands the process. This figure is meant to indicate that NASA will enter into a two-way communication with a partner agency or other entity that has the resources (relationships with users, decision support system, etc.) to implement a chosen application. As a result of this dialog the needs and products required for implementation will be identified, and then “performers” will be selected (likely through a solicitation process) to provide the link (e.g., data handling and processing, new products, etc.) between NASA resources and the partner’s application requirements. The partner will carry out the final implementation and interaction with ultimate users.

Some reference in the Applications Plan to how performers are solicited and selected via Broad Area Announcements or Request for Proposals, which NASA officials described to the committee, also would be illuminating.

A detail to note is that the multiple uses of the term “project” are somewhat confusing. The word might be removed from the second sentence in Section 2.3 to eliminate ambiguity in relation to those “projects” associated with solicited proposals.

### **Comments and Recommendations Regarding Section 3: Concept of Operations**

The committee recognized that the purpose of Section 3 is to describe the elements needed to implement the stated NASA applications strategy. These elements are (a) the management structure that includes headquarters Applications Division program managers and personnel at NASA Stennis Space Center; (b) a program framework, which reflects the relationship among the partners’ needs, NASA data, and the use of this data; (c) an implementation element, which describes the readiness of the application (“Application Research”), readiness of the data (“Validation and Verification”), and readiness for transferability to operations (“Applications Demonstration”); and (d) program action, which is a compilation of action items.

Nonetheless the committee found the description of these elements unclear and confusing, which may lead to confusion among users of the Applications Plan. The first three elements (a through c above) appeared to describe actions at a project level, with

Section 3.1 describing *project* management (within NASA ESE), Section 3.2 describing the *project* framework, and Section 3.3 covering *project* development and transfer. From those descriptions, the ESE Applications Program would consist of the collection of these activities, and thus constitute the program's operations. Thus, it appeared to the committee that the "Concept of Operations" can be described from a project rather than a program perspective, with the appropriate changes to subsection heading and text. In any case clarification of the above interpretation of Section 3 is needed. Further, the committee suggests that the section be titled "Concept of Implementation," as the section does not describe operational activities.

The committee agrees that the ESE Applications Program should provide the bridge between ESE's research domain and the public/private sector's operational activities. It seems that the Applications Plan should better articulate this bridging/transition.

The committee had the following comments about Section 3.2:

- This section seems to describe the life cycle of any particular application project rather than a program framework—perhaps because figure 2 depicts the flow of spatial data at the project level. If the program framework consists of a collection of these project information cycles, then the Applications Plan should explicitly state this.
- In general, the committee found figure 2 confusing and was uncertain how figure 2 related to the program framework, as opposed to a project life cycle, and how figure 2 and figure 1 should interrelate. As an example of this confusion, it is not clear what is meant by "tasking" because of its multiple uses.
- The committee notes that NASA does not address openness of data in the Applications Plan, particularly with respect to data that might be viewed as sensitive in an era of heightened attention to national security. NASA should consider making a statement on this topic in the document. An example of a relevant instance would be data collected on water infrastructure and how such data are made available and used.

The committee had the following comments about Section 3.3:

- This section does not sufficiently describe "Program Implementation" but is consistent with the view that implementation involves project development and applications transfer. The committee had concerns that this element was not sufficiently sensitive to the complex issues of transitioning the applications into operations, including the programmatic and budgetary readiness of the partner, continuity of NASA ESE data used for the application, broad user readiness, and so forth. As written, the Applications Plan reflects the implicit assumption that if the application demonstration is successful, then the partner and its users will quickly adopt the product. Explicit statements of how this transfer will be encouraged would be helpful.

One particularly important aspect has to do with what agency would be responsible for operational satellite programs. Currently NOAA is the only agency with a civilian operational satellite mission. Would other agencies also follow suit, would NOAA broaden its operational mission beyond weather forecasting and climate information, or would NASA take on an operational satellite mission for the other agencies such as EPA or USGS?

Section 3.4 does not seem to fit well into Section 3. While the committee recognizes that a strategic plan should include such action items, it would be more appropriate to include this information as a new Section 5. In addition, the committee encourages NASA to check the list for completeness and to consider adding actions such as evaluation of projects, to include progress metrics, identification of transition issues and success criteria, follow-up evaluations of transitioned projects, and so forth.

The committee further believes that NASA should augment the Applications Plan by adding a discussion of co-funding by federal partners, as such commitments ensure partner buy-in, ownership, and transition as appropriate.

#### **Comments and Recommendations Regarding Section 4: Performance Evaluation**

The performance evaluation section appears to rely mainly on concepts and terminology drawn from the Government Performance and Results Act (GPRA). Consistent with GPRA, this section of the Applications Plan identifies “program inputs and outputs, desired outcomes and expected impacts.” In the committee’s view this approach, standing alone, does not provide effective evaluation methodology. In particular, the measures in the current draft are sometimes vague, and they are not quantitative.

However, the committee does not want its recommendations to override any GPRA requirements and, based in part on comments by guest speakers, the committee is somewhat uncertain about expectations for this section of the Applications Plan. For this reason, the committee is offering alternative recommendations.

If the GPRA emphasis and format are required for the Applications Plan, the committee assumes that NASA will follow GPRA requirements regarding performance measures. In this case, the committee recommends using the most effective evaluation methodology consistent with GPRA requirements, especially including specific and measurable outputs and outcomes. (The committee fully understands that NASA will follow GPRA requirements in customary communications with Congress, OMB, OSTP, etc.). Alternatively, if the GPRA emphasis and format are not required for the Applications Plan, the committee recommends replacing the GPRA orientation with NASA-designed evaluation methodology and performance measures appropriate for the process and products set forth in the Applications Plan.

A central role for NASA’s partners and stakeholders is one of the great strengths of the NASA applications strategy and should be one of the Applications Plan’s most prominent features. However, the committee did not find performance measures designed for



partner/stakeholder evaluation of the quality of interactions between NASA and its partners/stakeholders or for assessing the extent to which the ESE Applications Program meets their needs. The committee believes that NASA's partners and stakeholders should participate in evaluating performance, and recommends that the Applications Plan include specific opportunities and mechanisms for partners and stakeholders to evaluate the extent to which the ESE Applications Program meets their needs.

### **Comments and Recommendations Regarding Appendices**

The three appendices are informative and useful adjuncts to the Applications Plan. At the same time, the committee recommends augmenting the existing appendices with additional information, and moving one appendix to the text and replacing it with related information in a recent NASA publication.

#### *Appendix A*

The committee recommends adding three additional terms to the definitions in Appendix A: *biogeophysical sciences*, *partner*, and *project*. The first term generated questions among experts on the committee; the last two words are terms of art that have special meanings in this plan.

Most committee members were familiar with the acronyms used throughout the Applications Plan, and NASA defined many acronyms in the body of the document. However, as a convenience for the general reader, the committee recommends including a *list of acronyms*, either as part of the existing glossary or as a new, separate appendix.

#### *Appendix B*

The introduction to Appendix B states that “[a]greements with Federal, state, local and tribal agencies, international organizations, and the private sector also contribute to the direction of the program” (page 14). However, the ensuing list of “drivers” appears to include federal programs only, with no examples of states, tribal entities, international organizations, or the private sector as drivers. Also, the “response” section refers to “selected academic institutions” without naming them.

Throughout the Applications Plan and in Appendix B, NASA provides solid information about and evidence of its federal partnerships by naming participating agencies and activities. This is one of the strengths of the document. At the same time, although the NASA applications strategy refers often to other organizations, as in the language cited above, specific examples are not given. If agreements with states, tribes, international organizations, or the private sector are, in fact, among the drivers, listing them along with the federal drivers would demonstrate that NASA's agreements reach beyond the federal sector.

If agreements with non-federal entities are in force or planned, the committee recommends adding two or three examples to the list in Appendix B, along with the names of some of the academic institutions involved. Adding this information would complete and balance the presentation. Alternatively, if NASA intends or expects that federal agencies alone will be drivers, the committee recommends that NASA review the introductory language quoted above to determine if it should be revised. The committee is not recommending expanding the list of drivers beyond the federal sector if NASA intends federal drivers only.

### *Appendix C*

Figure 2 (page 8) stimulated considerable committee discussion, including many questions about the meaning of various elements in the diagram. The committee then observed that the examples in Appendix C mapped to elements in figure 2. In fact, information in the appendix clarified the diagram and represented activities undertaken and results achieved in line with the process outlined in the figure. The committee recommends converting Appendix C to a “table of accomplishments” and incorporating the new table in Section 3.2 (page 8). The table would elaborate on ESE Applications Program participation in the process diagrammed in figure 2.

NASA’s presentation for the committee included numerous informative and clarifying slides. In particular, the committee felt that the 12 areas cited in the article by Birk and Hutchinson<sup>12</sup> (see page 3 of this report) offered information roughly comparable to that in Appendix C, but the article was more comprehensive and descriptive. The committee recommends replacing the information moved from Appendix C to Section 3.2 with the list of representative activities in the article. Lastly, Appendix C should have a note stating that this is an evolving process in which, for example, the list of national applications presented in the aforementioned slide undergoes periodic revision with input such as that from the regional workshops NASA has utilized in the past.

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<sup>12</sup>Preprint of article to appear in the August 2002 issue of Earth Observation Magazine (*EOM*), “Science and Society,” by R. Birk and C. Hutchinson.

## IV

### Summary

In summary, the committee was impressed with NASA's commitment to a strong civil ESE Applications Program and concluded that the NASA applications strategy includes elements that will serve as a good starting point for demonstrating that intent. The approach of partnering with other federal agencies to reach user communities is a sound one, and the management approach and prioritization of evaluation criteria for candidate applications areas presented in the Applications Plan are well reasoned. The committee is convinced, nonetheless, that the ESE Applications Program needs a period of stability and consistency to implement the NASA applications strategy. The NASA applications strategy would benefit from a clearer sense of connectivity, for example, with respect to linkages to past strategies and to other ESE programs.

Although the NASA applications strategy relies heavily on partnerships, this aspect is not fully developed in the Applications Plan, leaving a reader to wonder how fully it is realized in definition, scope, or practice. The Applications Plan could also benefit from more attention to its intended audience *outside* the federal government by providing more context, even at the expense of brevity. The community outside the federal government will benefit if the Applications Plan clearly establishes the priorities and the process and underscores the importance of mutually agreed upon success criteria. Lastly, the Applications Plan needs to articulate a strategy for translating concepts into more tangible actions.

With respect to how the Applications Plan itself is presented in the NASA document, the preface could better set the stage for the Applications Plan by identifying the intended audience and what NASA expects them to gain from reading the document. NASA should use the preface to articulate more clearly the scope and boundaries of the strategy. In addition, an expanded introductory section could address overarching themes, such as partnerships, context for specific missions that fit within the NASA applications strategy, and a list of drivers for the ESE Applications Division.

Overall, the committee believes that the Applications Plan is an important element of the overall Earth Science Enterprise strategy.

# Appendix A

## Letter of Request

National Aeronautics and  
Space Administration  
Headquarters  
Washington, DC 20546-0001



April 12, 2002

Reply to A22n of: Y

Mr. Joseph K. Alexander  
Director Space Studies Board, HA 584  
National Research Council  
2101 Constitution Ave. NW  
Washington, DC 20418

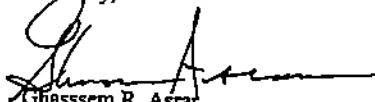
Dear Mr. Alexander:

NASA's Earth Science Enterprise has developed an "Applications Strategy: Next Decade" as a complementary document to its Research Strategy. Like the Research Strategy developed in 2000, the Applications Strategy defines the direction for this program over the next decade and identifies prioritization criteria to be applied to the candidate national applications to be undertaken.

We request that the Space Studies Board take the lead in establishing a study committee that draws on the range of the NRC's expertise in Earth science, remote sensing, and the practical applications of geospatial data to review the Applications Strategy. The emphasis in this strategy is on extending the use of Earth science observations and prediction capabilities by partnering with national organizations, such as sister federal, state and local agencies, to realize socioeconomic benefits by serving the public through decision support systems. We seek the NRC's assessment of the processes and prioritization criteria outlined in the Applications Strategy to enable the extension of NASA sponsored research and technology to national applications.

It would be most helpful to have the NRC's review of the Applications Strategy by September 2002. I look forward to receiving your study proposal. The current version of the document can be found at <http://www.earth.nasa.gov/visions/appstrat2002.pdf>. Please contact Mr. Ron Birk at 358-1701 or Mr. Greg Williams 358-0241 if you have any questions.

Cordially,

  
Ghasssem R. Asrar  
Associate Administrator for  
Earth Science

cc:  
Y/Mr. R. Birk  
Y/Mr. G. Williams

## **Appendix B**

### **NASA's Summary of the Evolution in Its Applications Strategy**

#### **Earth Science Enterprise Strategic Direction**

- **Heritage Program**
  - Accelerating commercial remote sensing industry
  - Conducting local, pilot projects
  - Providing grants to state, local, tribal, university, and private sector organizations
  - Building government-to-citizen relationships
- **Go Forward**
  - Accelerating societal benefits of Earth science
  - Conducting national, benchmark applications
  - Applying NASA systems engineering to national systems solutions
  - Building government-to-government-to-citizen relationships
  - Enabling decision support tools based on predictions and remote sensing data

## **Appendix C**

### **Committee Member Biographies**

**MICHAEL J. ARMSTRONG**, chair, is a principal at ICF Consulting in Fairfax, Virginia, where he manages support activities for the U.S. Department of Justice regarding victims of terrorism, the U.S. Food and Drug Administration regarding contingency planning for "mad cow" disease, and the U.S. Department of Defense regarding the capabilities of a common Web portal for first responder Internet applications. Mr. Armstrong was formerly the associate director for Mitigation and the Region VIII director for the Federal Emergency Management Agency (FEMA). During his tenure at FEMA, Mr. Armstrong administered the nation's disaster prevention programs, including pre- and post-disaster local planning, building design, land use, structural rehabilitation, and building removal grants. Mr. Armstrong spent more than a decade in local and state government, where he served as an assistant city attorney specializing in land use and personnel issues, and as deputy director of the Colorado Governor's Office of Energy Conservation.

**WILLIAM W. HOOVER** is a consultant for aviation, defense, and energy matters. He is the former executive vice president of the Air Transport Association of America, where he represented the interests of the U.S. major airlines industry, particularly as related to technical, safety, and security issues. Prior to holding this position, he served as the assistant secretary, Defense Programs, U.S. Department of Energy, where he was responsible for the U.S. nuclear weapons development program, including production, research, testing, safety, and security. He is also a major general, USAF (retired), and held positions of responsibility within NATO, at the Pentagon with the Secretary of the Air Force, and in Vietnam, where he commanded a combat air wing and flew as a fighter pilot. Mr. Hoover currently serves as chair of the NRC's Aeronautics and Space Engineering Board.

**DOROTHY E. PATTON** retired from the U.S. Environmental Protection Agency (EPA) as director of the Office of Science Policy in July of 2000, after having served the EPA in many capacities for 24 years. Dr. Patton began her EPA career in 1976 as an attorney in the agency's Office of General Counsel. She served as EPA's chief legal counsel in the administrative proceeding to cancel the dioxin-containing pesticide 2,4,5,-T and acted as the legal advisor on teams that developed national standards for contaminants such as particulate matter, sulfur dioxide, and carbon monoxide. Beginning in 1985 she assumed leadership responsibilities within EPA as the executive director of the Risk Assessment Forum, then executive director of the Science Policy Council, and then, director of the Office of Science Policy. In these capacities, she exercised significant influence over national policies related to protection of public health and safety.

**ROBERT J. PLANTE** is director of science at Raytheon Systems Company. Mr. Plante is a senior executive with over 25 years of top-level management experience in worldwide organizations both in government and the private sector. He is a nationally and

internationally recognized operational oceanographer and meteorologist. Throughout the course of his career Mr. Plante has demonstrated his expertise in human resources leadership, financial management, technical innovation, international and interagency agreements, high-level policy developments, and long-range planning. He was elected a fellow of the American Meteorological Society for outstanding contributions to and achievements in the atmosphere and ocean sciences and has been recognized by international and national counterparts for expertise in air-ocean sciences. Mr. Plante successfully directed DOD's principal Numerical Air-Ocean Prediction Center. Among his other personal achievements, he was recognized as the Navy's top weatherman.

HEIDI M. SOSIK is an associate scientist in the Biology Department at the Woods Hole Oceanographic Institution (WHOI). She accepted a scientific staff appointment at WHOI in 1996 after 2 years as a postdoctoral scholar. Her research has been at the interface of phytoplankton ecology and optical oceanography, with a focus on environmental regulation of phytoplankton biomass and productivity. She has used a variety of optical approaches to investigate photophysiology and nutrient limitation in phytoplankton from the California Current System, the Black Sea, the Southern Ocean, and coastal waters of the Northwest Atlantic Ocean. She is currently involved in the development of single-cell methods to characterize phytoplankton physiology and community structure and in the implementation of new sampling strategies for observing in the coastal ocean. Dr. Sosik is a member of the Phycological Society of America, the American Society for Limnology and Oceanography, and the American Geophysical Union.

MARK L. WILSON holds a dual appointment in the Departments of Epidemiology and of Ecology and Evolutionary Biology at the University of Michigan. After earning his Sc.D. in 1985 from the Harvard School of Public Health, he was a postdoctoral fellow at Harvard and then worked for 4 years at the Pasteur Institute in Dakar, Senegal. From 1991 to 1996 he was a member of the faculty at Yale University. Dr. Wilson's research addresses patterns and processes in disease ecology, particularly of human pathogens that are arthropod-borne or zoonotic. His studies of transmission dynamics, vector-host-parasite evolution, and environmental variation are directed at various viral, bacterial, and protozoal diseases. Dr. Wilson's approach employs field studies, laboratory experiments, and modeling, including the use of satellite images and geographic information systems. The goals are to reduce the risk of emerging diseases, to design ecologically sound development, and to understand the impacts of global environmental change on human health.

MILTON A. WILTSE is the Alaska State Geologist and director of the Alaska Division of Geological and Geophysical Surveys (DGGs) within the state's Department of Natural Resources. Dr. Wiltse has been employed as a professional geologist in the contiguous western states and Alaska for 34 years. During his time at DGGs, Dr. Wiltse has worked on projects throughout Alaska, including wide-ranging reconnaissance work that contributed to the state's choices when Alaska's statehood-entitlement lands were selected. Summer mineral exploration consulting work in Alaska encouraged him to accept a position as an economic geologist with the Alaska Division of Geological and Geophysical Surveys in 1974. He served in that capacity for 2 years until he resigned to

work as a consultant geologist in Alaska and other western states from 1976 to late 1979. In November of 1979, Dr. Wiltse returned to DGGS as the supervisor of the division's geochemistry laboratory.

ROBERT S. WINOKUR has been president and chief operating officer of the Earth Satellite Corporation since October 2000. He is responsible for the operation of EarthSat's remote sensing, weather, environmental, GIS, and image processing business areas. Mr. Winokur previously served as assistant administrator for Satellite and Information Services (NESDIS) within the National Oceanic and Atmospheric Administration. As assistant administrator, Mr. Winokur directed an integrated program for the development and use of all operational civilian satellite-based environmental remote sensing systems and NOAA's national climatic, oceanographic, and geophysical data centers. Mr. Winokur also served as the acting assistant administrator for weather services (NOAA).

ERIC F. WOOD is a professor in the Department of Civil Engineering and Operations Research, Water Resources Program, at Princeton University. His areas of interest include hydroclimatology with an emphasis on land-atmosphere interaction, hydrologic impact of climate change, stochastic hydrology, hydrologic forecasting, and rainfall-runoff modeling. Dr. Wood is an associate editor for *Reviews in Geophysics*, *Applied Mathematics and Computation: Modeling the Environment*, and *Journal of Forecasting*. He is a member of the NRC Board on Atmospheric Sciences and Climate (BASC), the Climate Research Committee, and the Committee on Hydrologic Science. He is a former member of the Water Science and Technology Board and of BASC's GEWEX panel.